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The Mibar Building - an Architect's and Engineer's perspective on the seismic strengthening of a heritage building

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ABSTRACT

This paper describes the seismic strengthening of the former NZ Racing Conference Building from the perspective of an architect and an engineer. Now known as the Mibar Building, this 6 storey reinforced concrete building was constructed in 1960-61 on a prominent corner site in the Wellington CBD. It is listed as a Heritage Building in the operative Wellington City District Plan and has several distinctive features including a curved glazed frontage and unique wave form canopy. In terms of earthquake performance it has shortcomings that are typical of reinforced concrete structures of its era and was assessed as earthquake prone. Of most concern was a structural discontinuity at the ground floor on the curved north frontage, where columns had the potential to fail in shear and compromise gravity load paths. Strengthening to this curved frontage has improved the building's rating to 40-50% NBS. The constrained site, the building's heritage nature, its high-profile corner location, and tenanted status all contributed to the project's complexity. It is hoped that the learnings from this case study will inform the strengthening of other historic concrete buildings.

1 INTRODUCTION

The Mibar Building, constructed in 1960-61, is located at 81-87 Victoria Street in Wellington and faces Wakefield Street from its prominent corner site (Fig. 1). This six storey reinforced concrete building is listed as a Heritage Building in the operative Wellington City District Plan. A lightweight one storey penthouse was added in 1974. In plan it has an elongated rectangular shape with a curved corner frontage. It was built as the head office of the New Zealand Racing Conference, a use it maintained for over 20 years, and is currently best known as the home of the Lido Café that was established in 1990.

Figures 1 and 2: Site plan (LINZ Data Service); View from within The Lido cafe


Figures 3 and 4: Views from Wakefield Street and Victoria Street

1.1 Architecture

Some of the following text is sourced from the Wellington Heritage website (http://wellingtoncityheritage.org.nz/buildings/301-450/318-the-former-racing-conference-building).

The building is an unusual Expressive Modernist building constructed with a fine palette of high quality finishing materials. Its distinctive wave form canopy, curved glass windows and quirky decorative elements are atypical of 1950s Modernist design, perhaps making it one of the most distinctive and well-known Wellington buildings of that era. Of note is the sweep of full height glazing that surrounds the vibrant Lido café and both protects and connects the café with the world outside. The unusual curved plan is reinforced visually by the curved glass of the north-western windows, the arched window head, and the undulating canopy which helps create a distinct street-presence for the venue (Figs. 2, 3 and 4).

The building is of historic importance as the purpose-built head office of the New Zealand Racing Conference. Horseshoe motifs on the balcony handrails provide a subtle hint to this past use. The building was a recipient of an NZIA Wellington Branch 25 year award and was voted the Best Dressed in Wellington at the Architectural Centre's 2005 AGM.

Occupying a prominent corner site, the building contributes to the townscape of the inner city, clearly defining a busy intersection. The exterior form and materials of the building remain largely as originally designed and built.

Maintaining the building's distinctive architecture and heritage was a key driver for the design team in developing a successful strengthening scheme.

1.2 Structure

Structon Group designed this in-situ reinforced concrete building and the later addition of a lightweight steel framed penthouse. Lateral loads are resisted by shear walls with some contribution from moment frames. The wall elements (external walls and shear core) are concentrated in the east and south of the building creating a plan stiffness eccentricity and associated torsional effects. There are moment frames on the north and west elevations, and on internal gridlines. A typical floor plan is shown below (Fig. 5).

The building's columns are supported by subfloor columns that are tied together with ground beams. These subfloor columns typically extend into large concrete caisson tubes which are founded at varying depths. Concrete plugs seal off the base of the tubes, over which reinforced concrete pads have been cast. Gravelly fill in, and above, the caissons was used to build up to the ground floor slab.

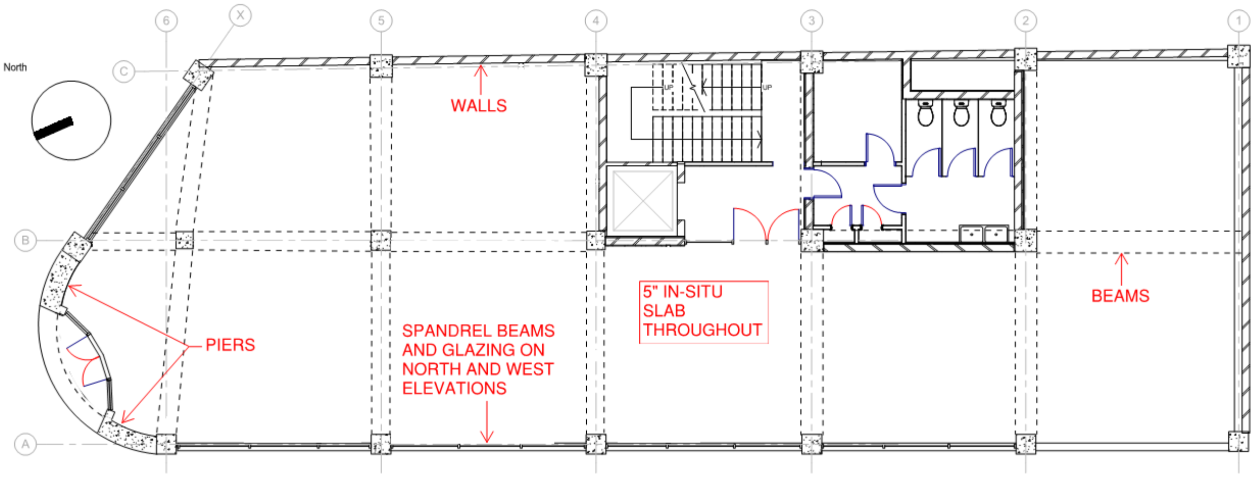

Figure 5: Typical Floor Plan

1.3 Seismic Assessment

The project came to the office when the building owner received notice from Wellington City Council (WCC) that the building was potentially earthquake prone under Section 124 of the Building Act 2004. A detailed seismic assessment was then undertaken which rated the building <33%NBS at IL2. The building is typical of reinforced concrete structures of its era; it has round bar reinforcing, is not capacity designed and lacks detailing for ductility. Specifically, the potential plastic hinge regions and beam-column joints of the moment frames were found to be at most nominally ductile according to current standards. A beneficial feature of the building is the embedded columns in the shear walls which act similarly to a confined boundary element in current wall design, providing ductility under cyclic loads.

There are two wall piers on the curved north elevation that help to control the torsional response of the building. The piers go between the roof and the first floor but do not continue to ground; they terminate at first floor on a curved transfer/spandrel beam (Fig. 6). This beam forms a moment frame with four columns that continue to ground floor. The assessment found that these elements are highly loaded and had the potential to fail in shear which would compromise gravity load paths.

2 SEISMIC STRENGTHENING DESIGN

2.1 Strengthening Target and Methodology

A key objective was to strengthen the building in such a way that it can be strengthened further in future without nullifying the work carried out. It was important for the exterior of the building to remain unchanged, to preserve its heritage visual features. The client sought a cost-effective solution and wished to maintain the existing functional usage of the interior spaces.

Multiple strengthening concepts were presented to the client and the concept that best met the project requirements was selected. This was to achieve 40-50%NBS by targeting the critical curved north elevation. New concrete elements were overlaid behind the existing columns, first floor beam and balcony balustrade wall, and steel angles bolted to the wall piers (Fig. 6). The demands on one of the concrete columns were such that an embedded steel UC section was used rather than conventional reinforcing.

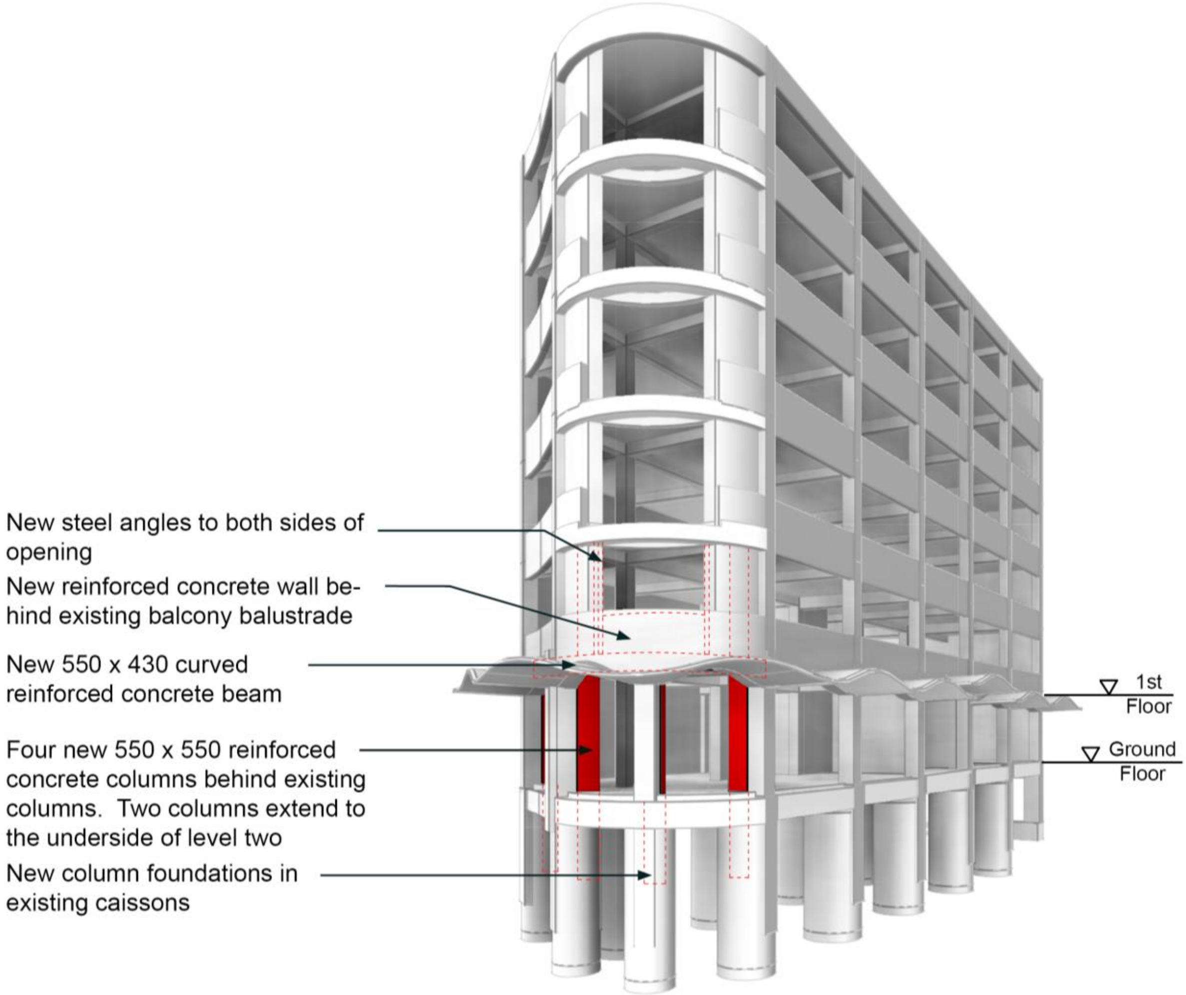

Figure 6: Strengthening Scheme

2.2 Architectural Commentary

Strengthening options were presented to the WCC Heritage and Planning Advisors through the WCC building resilience initiative. This included WCC in the decision-making process and enabled a design to be selected with minimum chance of it requiring resource consent. Working alongside the council also provided an opportunity for our client to apply for a Built Heritage Incentive Fund, which reimburses building owners for taking buildings with heritage significance off the earthquake prone register. The cost of building code upgrades, such as accessibility and fire protection, can add to the difficulty and expense of preserving older historic buildings.

A concrete strengthening solution was the preferred option. It was in keeping with the existing concrete building, visually discreet and allowed matching of colours, textures, dimensions and detailing between the old and the new.

Aspects of the strengthening were potentially tricky to construct and so Early Contractor Involvement was utilised during the design phase. This allowed the design to be tailored to suit the methodology of a contractor, providing more cost and programme certainty for the client.

2.3 Structural Commentary

The strengthening has removed the critical weakness at the ground floor on the curved north elevation, where the beam and columns had the potential to fail in shear and compromise gravity load paths. As seen in Fig. 6 the work was confined to this relatively small portion of the building. By targeting this weakness the building's inherent strength provided by the numerous shear walls (Fig. 5) is able to be better utilised.

The strengthened beam and columns are now limited by flexure rather than shear to protect the gravity load paths. To account for potential degradation of shear capacity in existing elements, due to the lack of ductile detailing, we assigned a shear capacity threshold 1.5 times higher than the flexural capacity.

Linear analysis methods were used in accordance with NZS 1170.5 however these were supplemented with a nonlinear static analysis to review the building's post-elastic behaviour. With reference to ASCE 41-13, nonlinear hinges were assigned to the ETABS model at locations with potential to yield. An example of the plastic hinge formation in the longitudinal direction is shown below (Fig. 7).

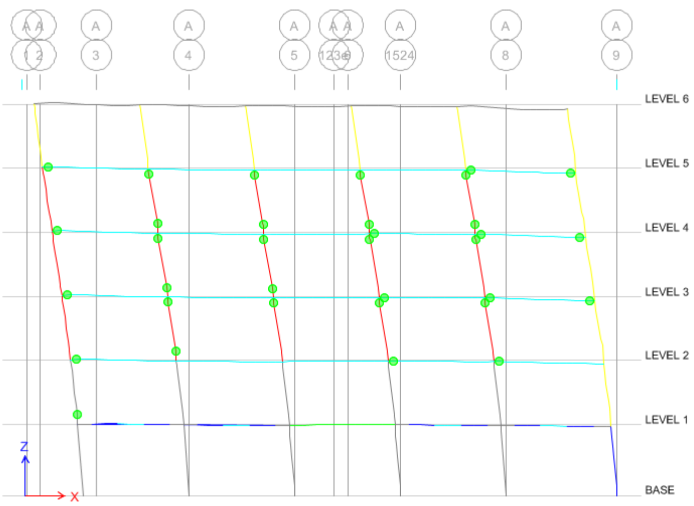

Figure 7: Plastic hinge formation in ETABS model on gridline A

3 CONSTRUCTION OBSERVATIONS

Although it was a reasonably conventional concrete strengthening, several construction challenges were encountered. The caisson that the new steel UC column was to found in was completely filled with concrete; a 500mm dia., 1200mm deep core was drilled and removed with some difficulty to give the UC adequate embedment. Fig. 8 shows the UC seated in the cored hole. Another caisson was letting in groundwater through a crack in its concrete lining. The saturated fill in the caisson was hydro vacuum excavated and the reinforcing placed (Fig. 9). During this time the caisson filled with water again and had to be de-watered.

The new curved beam proved to be the greatest construction challenge. Lapped/coupled curved bars, transverse reinforcement and dowel bars at close centres were all pieced together within existing beam reinforcing (e.g. Fig. 10). The contractor aptly described the process as “knitting steel”.

Similarly to the beam, the new columns had substantial transverse reinforcement and dowel bars (Fig. 11) that made conventional vibration compaction difficult. The contractor decided on the innovative approach of pumping self-compacting concrete from the base of the columns. We had seen this method used successfully on another project and this proved to be the case on this project, providing a uniform finish.


Figures 8 and 9: Steel UC and reinforcing cored into caisson; Ground water in caisson


Figures 10 and 11: Looking down on the curved beam; Column reinforcing

4 PRE- AND POST-STRENGTHENING COMPARISON

Figs. 12 and 13 are ‘before’ and ‘after’ images taken inside the Lido café. Note the new overlay to the perimeter columns which does reduce floor space but enhances the function of the space by providing more privacy for seating arrangements. The old ceiling was removed and the first-floor structure painted, creating a light and lofty feel. The new curved beam is exposed but sits above the arch of the windows, and blends in seamlessly with the existing beams, making it appear to be part of the existing structure.

Figure 12: Pre-strengthening view inside Lido Café, ground floor (2012)

Figure 13: Post-strengthening view inside Lido Café, ground floor (2018)

5 CONCLUSIONS

The Mibar Building has had an interesting history as the purpose-built head office of the New Zealand Racing Conference, and is currently best known as the home of the Lido café that was established in 1990. It has an unusual Expressive Modernist style as seen in its distinctive wave form canopy, curved glass windows and quirky decorative elements. These and other factors led to it being listed as a Heritage Building in the operative Wellington City District Plan. It was important to preserve this heritage while improving earthquake safety.

The strengthening was confined to a relatively small portion of the building at the curved north elevation. It removed a critical weakness at the ground floor, where a beam and columns had the potential to fail in shear and compromise gravity load paths. By targeting this weakness the building's inherent strength from its numerous shear walls is able to be better utilised. To strengthen the building to a higher rating would have required much more widespread modifications. The option remains for this to be carried out in future.

The new curved beam proved to be the greatest construction challenge. Curved main bars, transverse reinforcing and dowel bars at close centres were all pieced together within existing beam reinforcing. The contractor aptly described the process as "knitting steel". The heavily reinforced columns were poured successfully using bottom-pumped, self-compacting concrete.

The constrained site, the existing building's heritage nature, its high-profile corner location and tenanted status made this project a technical and complex seismic strengthening project, but effective collaboration between the architect, engineer, local territorial authority, conservation architect, contractors, and client, made for a very successful project.

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